SCR Catalyst Management Strategies to Reduce Operating Expenses

Stanley S. Mack and Joseph A. Patchett
Stanley.Mack@Engelhard.com and Joe.Patchett@Engelhard.com
(908) 205 6174 and (908) 205 6072
Fax (908) 205 6146
Engelhard Corporation
101 Wood Ave.
Iselin, NJ 08830-0770

Summary

The replacement of spent catalyst represents a significant (>40%) operating cost for a SCR system. To minimize this expense various catalyst management schemes have been proposed. Engelhard has developed a process for re-using honeycomb and metal supports. This approach can realize customer savings of greater than 30% on the cost of replacement SCR catalyst. The economic impact of substrate recycling on replacement catalyst cost are evaluated using a total cash value and the net present value.

Introduction

The periodic replacement of SCR catalyst constitutes almost 50% of the annual operating cost of an SCR system. Even when SCR catalysts are used in conjunction with a SNCR system, the hybrid approach, catalyst costs represent a large fraction of the annual operating expenses. Various schemes exist that optimize the number of change outs and catalyst volume to reduce expenses when evaluated over multiple years.

There are two approaches to SCR catalyst design, homogeneous or plate-type catalyst. For homogeneous catalyst, the active component is fabricated into the structure that generates the geometric surface area. In SCR catalysts this structure is usually an extruded honeycomb. Therefore, these materials must provide catalytic activity, structural support and be optimized for extrusion. Achieving these diverse goals may require comprising some aspects of one property to create a workable solution.

The other approach is to separate the support function from the catalyst. By doing so, the catalyst and the support are optimized independently of each other. Regardless of the catalyst design, conventional practice adds or eventually replaces deactivated catalyst with new catalyst. However, in some plate-type SCR catalysts, only the catalytic function is lost, the support is still usable.

Catalyst Management Using Substrate Recycling

All the catalyst management strategies proposed thus far rely on the replacement of new catalyst throughout out the life of the SCR or hybrid system. Using the composite design for SCR catalysts an alternative approach separates the support from the spent catalyst and reuses the support. This approach is cost effective because the support lasts considerably longer than the active catalytic material and represents a significant portion of the total catalyst cost. There is also the benefit of potentially lower disposal cost because of reduced disposal volume.

This paper examines the economic advantages of support or substrate recycling by evaluating the catalyst cost for a 150 MW boiler, retro-fitted with either a full scale SCR system or a hybrid SNCR/SCR system, over a ten year period. For the hybrid case, the SCR catalyst is intended primarily for ammonia slip control from the SNCR system. Figure 1 describes the cases study boiler. Figures 2 and 3 summarize the financial assumptions and provide the catalyst volumes used in each case. Costs are evaluated using the Net Present Value (NPV) of the catalyst and on the total cash outlay over the ten year period. Capital cost recovery has not been included in this analysis. For the full scale SCR cases, a published catalyst management strategy is used, illustrated in Figure 4. This strategy uses the addition of a third layer after the second year, followed replacement of each layer to give a ten year life. The SNCR/SCR hybrid cases uses a single catalyst layer that is replaced after 2 years.

The costs of replacement catalyst over a ten year life are illustrated in Figure 5 for a full scale SCR system on a single 150 MW boiler. In this analysis new catalyst is still required after 2 years and after 5 years. The ability to use recycled substrate is not available until the catalyst change in year 6. At 75% of the original cost there is a saving of 0.77 million dollars in total catalyst cost compared to all new catalyst. If recycled catalyst is 50% of the original catalyst cost, then these savings increase to 1.5 million dollars. The net present value of the catalyst with no recycling would be 3.68 million dollars. Using recycled catalyst at 75 and 50% of the original cost lower the net present value of the catalyst to 3.36 and 3.05 million dollars respectively.

If multiple boilers are present, then the opportunity to use recycled catalyst occurs earlier in the change out cycle. Recognizing that even the support does not have an infinite life, the assumption is made that only half the catalyst bed is available for recycling when the bed is replaced after ten years. The opportunity to use cheaper catalyst earlier in the replacement cycle results in a total saving of 3.5 million dollars or a savings of 20% in the net present value of the catalyst when the catalyst is 50% of the original cost.

For a hybrid SNCR/SCR, the entire catalyst bed is replaced after 2 years. Figure 6 summarizes the catalyst cost over the ten years operating life for a single boiler. Using substrate recycling to lower the replacement catalyst cost results in a saving of 16 and 33% when the recycled catalyst is 75 and 50% of the original catalyst cost. The reduction

in the net present value of the catalyst using recycled is 13 and 27% of the original cost when the recycled catalyst is 75 and 50% of the original cost.

Conclusions

The use of substrate recycling offers the opportunity to significantly reduce the cost of replacement catalyst in full scale and hybrid SNCR /SCR hybrid systems. Savings are 10-20% when recycled catalyst is 50-75% of the original cost in a full-scale SCR system. Savings of 13-30% in the net present value of the catalyst are possible in the hybrid SNCR/SCR because of more frequent catalyst change outs. These savings assume no catastrophic upsets in the boiler operation. If the need to replace catalyst occurs earlier or requires a greater volume, then the cost savings can increase dramatically.

Figure 1
Case Study Boiler

- 150 MW
- Pulverized Coal
- Dry Bottom
- 65% Load Factor
- Multi-Boiler Case Assumes Two 150 MW Boilers at the Same Site

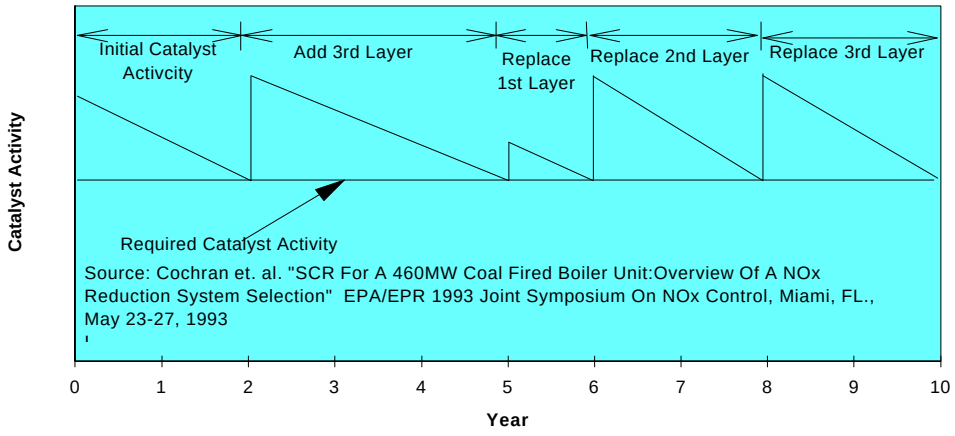
Figure 2
Cost Assumptions

- Full Scale SCR Uses 5700 Cubic Feet of Catalyst
- Hybrid SNCR/SCR Uses 1200 Cubic Feet Catalyst
- 10% Interest
- Catalyst Cost 400 $/Cu. Ft
- Recycled Catalyst Costs Either 50% or 75% of Original Catalyst Cost

Figure 3
Catalyst Configurations Studied

- Full Scale SCR, 80% Reduction, 5 ppm NH3 Slip
- Hybrid SNCR/SCR: SCR Reaction Is Used to Control NH3 Slip From an SNCR System
- Single Boiler
- Multiple Boilers at the Same Site

Figure 4
Typical Catalyst Replacement Plan



Source: Cochran et. al. "SCR For A 460MW Coal Fired Boiler Unit:Overview Of A NOx Reduction System Selection" EPA/EPR 1993 Joint Symposium On NOx Control, Miami, FL., May 23-27, 1993

Figure 5
Catalyst Expense Versus Operating Time
Full Scale SCR
Replacement Catalyst at 50, 75 and 100% of Original Cost

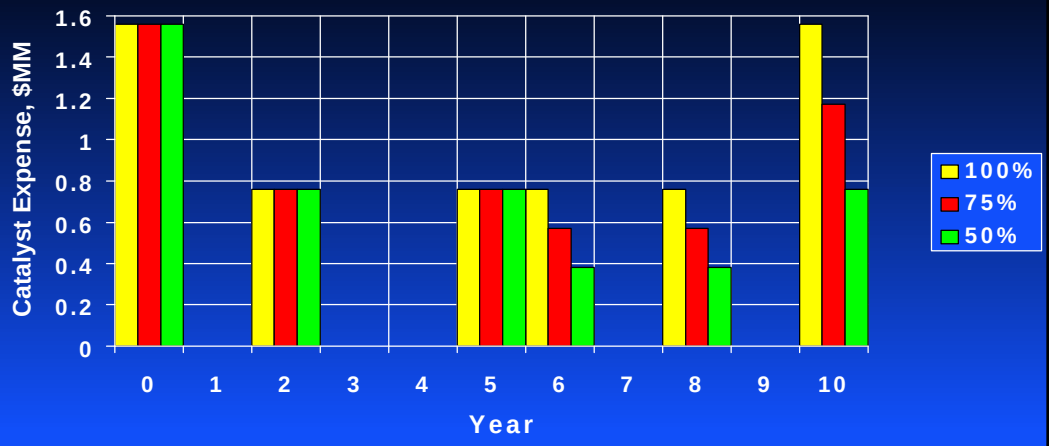


Figure 6
Cumulative Catalyst Expense Over 10 Years
Hybrid SCR, Two Year Catalyst Replacement